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ATTACK HELICOPTER HIGH-ALTITUDE EVALUATION, BLACKHAWK S-67 HELICOPTER

George M. Yamakawa, et al

Army Aviation Systems Test Activity
Edwards Air Force Base, California

July 1972

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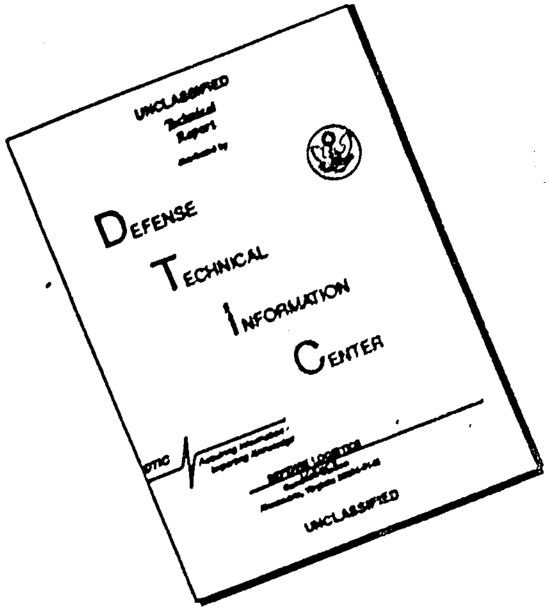

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ATTACK HELICOPTER HIGH-ALTITUDE EVALUATION, BLACKHAWK S-67 HELICOPTER

FINAL REPORT 5 July through 13 July 1972

GEORGE M. YAMAKAWA, Project Officer
ALBERT L. WINN, Project Engineer
WILLIAM P. HORTON, MAJ, FA, US ARMY
Project Pilot

JULY 1972 | 29 | 8

USAASTA PROJECT NO. 72-26

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The US Army Aviation Systems Test Activity conducted a limited evaluation of the performance and handling qualities of the Sikorsky S-67 Blackhawk helicopter at a high-altitude test site during the period 8 to 13 July 1972. This evaluation, which required [illegible] hours of productive flight time, was performed at Alamosa, Colorado, at density altitudes of 7830 to 10,790 feet. Testing at near sea-level conditions had been conducted previously at the contractor facility at Stratford, Connecticut. Except as specifically noted in this report, the performance and handling qualities at high altitude were essentially unchanged from those reported during the previous low-altitude testing. The standard-day in-ground-effect and out-of-ground-effect hover ceilings at the estimated TOW mission gross weight of 18,700 pounds are 8800 and 5500 feet, respectively. The sea-level, standard-day, out-of-ground-effect hover maximum gross weight is 21,340 pounds. The S-67 helicopter cannot hover out of ground effect at 95°F at any altitude at the TOW mission gross weight of 18,700 pounds. At sea level on a 95°F day, the maximum out-of-ground-effect hover gross weight is 18,450 pounds. Loss of directional control due to reaching the left directional control travel limit in right sideward flight above 15 knots true airspeed was the only deficiency noted. No shortcomings were identified which had not been previously identified during the prior tests at low altitude.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Limited evaluation						
Performance and handling qualities						
Sikorsky S-67 Blackhawk helicopter						
High-altitude test						
Density altitudes of 7830 to 10,790 feet						
Unchanged						
Cannot hover						
Maximum out of ground effect						
Loss of directional control						
Deficiency noted						
No shortcomings						

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BLACKHAWK S-67 HELICOPTER

FINAL REPORT

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US ARMY AVIATION SYSTEMS TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

ABSTRACT

The US Army Aviation [illegible] Test Activity conducted a limited evaluation of the performance and handling qualities of the UH-60A Black Hawk helicopter at a high-altitude test site during the period 5 to 15 July 197[illegible]. This evaluation, which required 5 hours of productive flight time, was performed at Alamosa, Colorado, at density altitudes of 7830 to 10,790 feet. Testing at near sea-level conditions had been conducted previously at the contractor facility at Stratford, Connecticut. Except as specifically noted in this report, the performance and handling qualities at high altitude were essentially unchanged from those reported during the previous low-altitude testing. The standard-day in-ground-effect and out-of-ground-effect hover ceilings at the estimated ROC mission gross weight of 1[illegible],[illegible]00 pounds are [illegible]800 and [illegible] feet, respectively. The sea-level, standard-day, out-of-ground-effect hover maximum gross weight is 21,340 pounds. The UH-60 helicopter cannot hover out of ground effect at 95°F at sea level at the ROC mission gross weight of 18,70[illegible] pounds. At sea level on a 95°F day, the maximum out-of-ground-effect hover gross weight is 18,4[illegible] pounds. Loss of directional control due to reaching the left directional control travel limit in right sideward flight above 15 knots true airspeed was the only deficiency noted. No shortcomings were identified which had not been previously identified during the prior tests at low altitude.

TABLE OF CONTENTS

INTRODUCTION

BACKGROUND

1. The S-67 Blackhawk is a prototype attack helicopter designed and built by Sikorsky Aircraft Division (SAD) of United Aircraft Corporation under an in-house funded program independent of any military requirement. The design phase was initiated on 20 November 1969 and construction began 15 February 1970. The first flight of the S-67 was on 20 August 1970. The US Army Aviation Systems Test Activity (USAASTA) was tasked by US Army Aviation Systems Command (AVSCOM) test request (ref 1, app A) to conduct an evaluation of the S-67 helicopter to support the Attack Helicopter Requirements Evaluation (AHRE) being performed for the US Army Combat Developments Command. Low-altitude test results were published in USAASTA Project Report No. 72-09, July 1972 (ref 2). Further testing at high altitude was subsequently requested by AVSCOM Test Directive No. 72-26, 5 July 1972 (ref 3).

TEST OBJECTIVES

2. The objectives of this test were to evaluate the hover performance, level flight performance with the landing gear extended, and sideward flight characteristics of the S-67 helicopter at high altitude.

DESCRIPTION

3. The S-67 is a tandem-seat, twin-turbine, armed helicopter. It incorporates five-bladed main and tail rotors and is powered by two T58-GE-5 turbine engines. A wing provides additional lift and attachment points for external stores. The wing panels have speed brakes to control dive airspeed and increase deceleration capability. The main rotor blades feature swept tips designed to enhance high-speed capability. A stability augmentation system (SAS) and a feel augmentation system (FAS) are incorporated to improve handling qualities. A detailed description and photographs of the S-67 are contained in reference 2, appendix A.

SCOPE OF TEST

4. The Sikorsky S-67 was evaluated to determine high-altitude performance and handling qualities. High-altitude tests were conducted at Alamosa, Colorado, (field elevation 7535 feet) during the period 8 to 13 July 1972. These tests required 5 hours of productive flight time, all of which was accomplished in the clean configuration (no external stores) at the test conditions shown in table 1. Handling qualities were evaluated with respect to the applicable requirements of military specification MIL-H-8501A (ref 4, app A). The flight restrictions and operating limitations applicable to this evaluation are contained in the pilot's checklist (ref 5) as modified by the safety-of-flight release (ref 6).

Table 1. Test Conditions.[1]

Type of Test	Nominal Gross Weight (lb)	Nominal Density Altitude (ft)	Nominal Trim Calibrated Airspeed (kt)	Rotor Speed (rpm)
Hover performance[2]	16,450 to 18,860	7,830 to 8,110	Zero	199 to 213
Level flight performance	17,023	10,790	53 to 152	211
Sideward and rearward flight performance	16,750	8,050 to 8,380	Zero to 40 (fwd)[3]	211
			Zero to 35 (left)[3]	
			Zero to 15 (right)[3]	
			Zero to 30 (rear)[3]	

[1]Center-of-gravity range: FS 274.1 to FS 274.5 (aft).
Clean configuration: no external stores.
[2]In ground effect (10-foot main landing gear height).
Out of ground effect (100-foot main landing gear height).
[3]Knots true airspeed.

METHOD OF TEST

5. Established flight test techniques and data reduction procedures were used (refs 7 and 8, app A). The test methods are briefly described in the Results and Discussion section of this report. A Handling Qualities Rating Scale (HQRS) was used to augment pilot comments relative to handling qualities (app B). Data reduction techniques utilized are described in reference 2, appendix A.

6. The flight test data were obtained from test instrumentation displayed on the pilot and copilot/gunner panels and recorded on magnetic tape. A detailed listing of the test instrumentation is contained in reference 2, appendix A.

CHRONOLOGY

7. Chronology of the S-67 attack helicopter evaluation is as follows:

Test directive received	5 July 1972
Test started	8 July 1972
Test completed	13 July 1972

RESULTS AND DISCUSSION

GENERAL

8. A limited evaluation of the performance and handling qualities of the S-67 helicopter was performed at high altitude in the clean configuration. Except as specifically noted in this report, the performance and handling qualities were essentially unchanged from those reported during previous low-altitude testing. The standard-day in-ground-effect and out-of-ground-effect hover ceilings at the estimated TOW mission gross weight of 18,700 pounds are 8800 and 5500 feet, respectively. The maximum sea-level, standard-day out-of-ground-effect hover gross weight is 21,340 pounds. The S-67 helicopter cannot hover out of ground effect at 95°F at any altitude at the TOW mission gross weight. At sea level on a 95°F day, the maximum out-of-ground-effect hover gross weight is 18,450 pounds. Loss of directional control due to reaching the left directional control travel limit in right sideward flight above 15 knots true airspeed is a deficiency. No additional shortcomings were identified which had not been previously reported in reference 2, appendix A.

PERFORMANCE

Hover Performance

9. Low-altitude hover performance tests are described in paragraphs 11 and 12 of reference 2, appendix A. High-altitude in-ground-effect (IGE) hover testing was accomplished using a tether line anchored to a concrete deadman to provide a 10-foot main landing gear height. A calibrated load cell was installed between the bottom of the cable and the deadman to measure cable tension. A two-axis accelerometer was installed in the load cell to provide a cockpit presentation of cable angle information. The data were recorded at stabilized load cell readings with engine torque values up to the maximum available, as governed by turbine inlet temperature limits. In-ground-effect hover tests were conducted at an average gross weight of 18,250 pounds within a rotor speed range of 200 to 213 rpm. Out-of-ground-effect (OGE) hover testing was accomplished using the free-flight hover technique due to the lack of sufficient engine power to permit lifting of the tethered hover cable. Out-of-ground-effect hover testing could only be accomplished during early morning, low-temperature conditions. Constant altitude (100-foot main landing gear height) was maintained by reference to the radar altimeter, and a steady position over a spot on

the ground was maintained by visual reference cues. The OGE hover tests were conducted at an average gross weight of 16,630 pounds within a rotor speed range of 199 to 213 rpm. Results of the high-altitude hover tests are presented in figures 1 through 7, appendix C, and summarized in table 2.

Table 2. Hover Performance.

Temperature	Hover Height[1]	Weight (lb)	Ceiling (ft)
Standard day	IGE	18,700	8,800
		23,700	Sea level
	OGE	18,700	5,460
		21,340	Sea level
Hot day (95°F)	IGE	18,700	2,300
		20,520	Sea level
	OGE	18,700	Not possible
		18,450	Sea level

[1]In ground effect (10-foot main landing gear height).
Out of ground effect (100-foot main landing gear height).

10. Tail rotor performance characteristics are shown in figures 4 through 7, appendix C. Figures 6 and 7 compare the nondimensional tail rotor performance at near sea-level conditions and at high altitude. Although it appears that the gradients of tail rotor thrust coefficient versus tail rotor power coefficient increase at high altitude, indicating that the tail rotor is less efficient at high altitude, there are insufficient data available to conclusively substantiate this trend.

Level Flight Performance

11. Previous level flight testing at low altitude is described in paragraphs 13 and 14 of reference 2, appendix A. Level flight performance tests at high altitude were conducted to determine power required and fuel flow as functions of airspeed. In addition, specific range, long-range cruise speed (V_{cruise}), endurance

speed (speed at minimum power required for level flight), and maximum level flight airspeed at takeoff power (V_{max}) were determined. Data were obtained in stabilized level flight at incremental airspeeds from 63 knots true airspeed (KTAS) to V_{max}. The drag effects of the landing gear were determined by repeating this test, with the landing gear extended, over the airspeed range from 80 to 124 KTAS. A constant gross-weight-to-density ratio (W/σ) of 23,630 pounds was maintained by increasing altitude as fuel was consumed. Tests were conducted at the conditions listed in table 1. The results of these tests are presented nondimensionally in figure 8, appendix C, and dimensionally in figures 9 and 10.

12. The increase in equivalent flat plate area for the gear-extended configuration is presented in figure A. The highest equivalent flat plate area increase of 9.5 square feet occurred at 124 KTAS. Figure B presents a comparison of the level flight power required for the clean and gear-down configurations at standard-day conditions, a 7500-foot altitude, 211-rpm rotor speed, and a 18,700-pound gross weight. Retraction of the landing gear at 124 KTAS (maximum gear-down speed) yielded an increase in airspeed of 13 KTAS. A comparison of level flight performance at sea level and at 7500 feet is presented in table 3.

FIGURE A
CHANGE IN EQUIVALENT FLAT PLATE AREA
DUE TO CONFIGURATION CHANGES

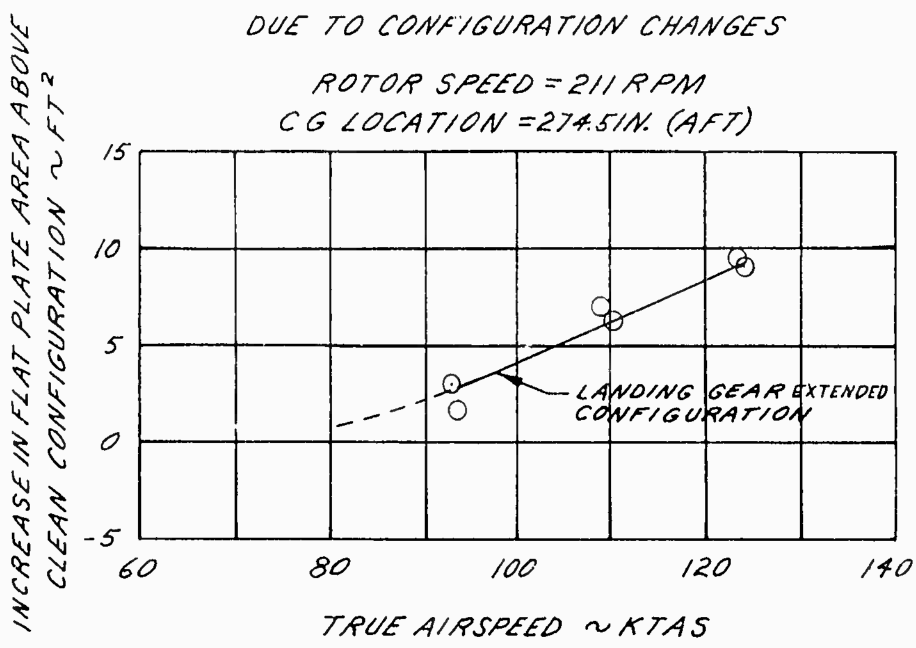


FIGURE B
LEVEL FLIGHT PERFORMANCE COMPARISON
S-67 S/N N671SA
T58-GE-5 ENGINES

GROSS WEIGHT ~LB	CG LOCATION ~IN.	PRESSURE ALTITUDE ~FT	OAT ~°C	ROTOR SPEED ~RPM	C_T	CONFIGURATION
18700	274.2 (AFT)	7500	0.1	211	0.00696	CLEAN

STANDARD DAY

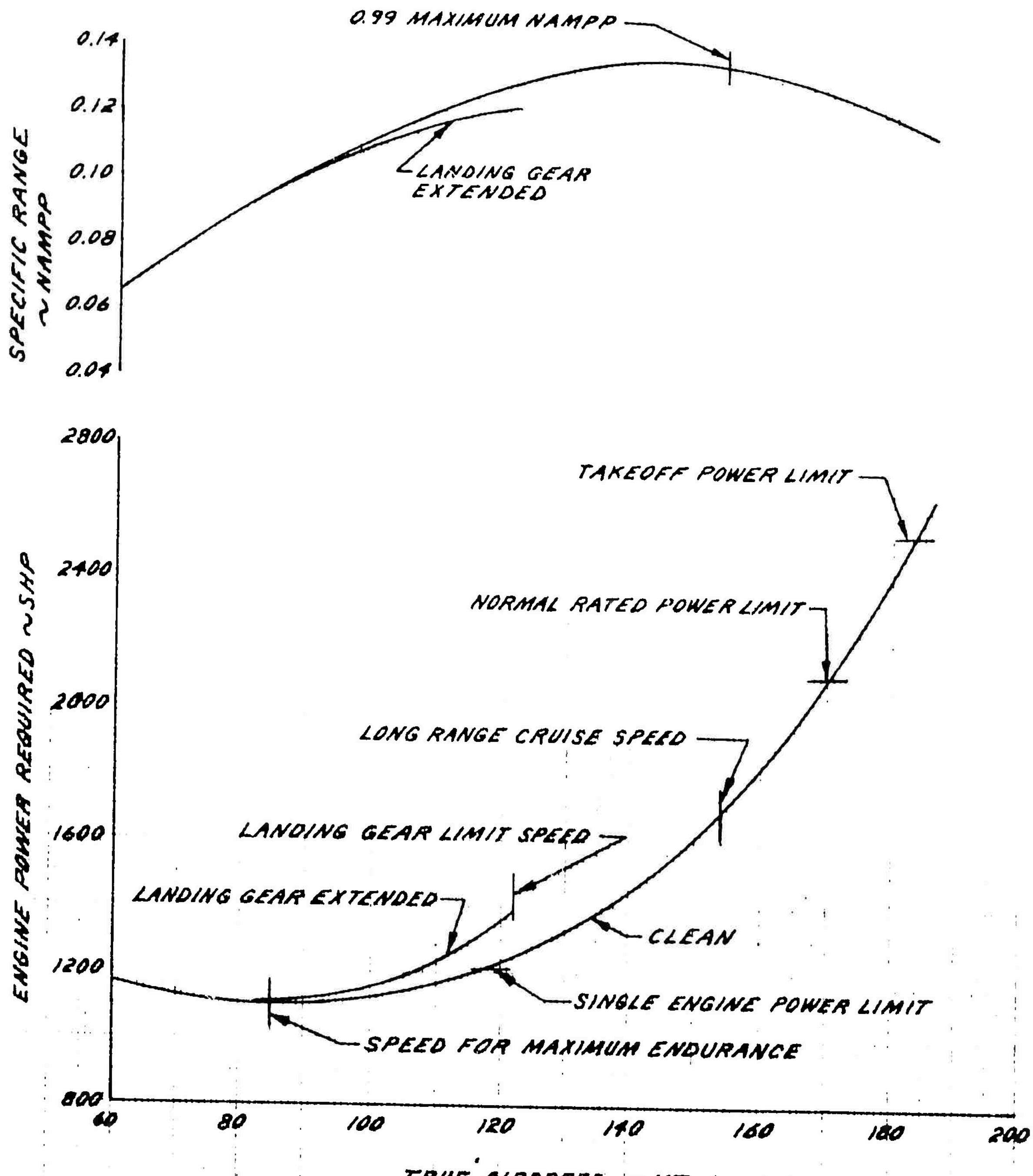


Table 3. Level Flight Performance.[1]

Altitude (ft)	Sea level	7,500
0.99 maximum specific range (NAMPP)	0.111[illegible]	0.1346
Long-range cruise speed (KTAS)	1[illegible]1	154
Airspeed for maximum endurance (KTAS)	79	85
Airspeed at normal rated power V_H (KTAS)	172	179
Airspeed at takeoff power V_{max} (KTAS)	[illegible]183	[illegible]

[1]Gross weight: 18,700 pounds.
Rotor speed: 211 rpm.
Center-of-gravity location: FS 274.2 (aft).
Clean configuration: no external stores.
[2]Transmission limit.

HANDLING QUALITIES

Sideward, Rearward, and Slow-Speed Forward Flight Characteristics

13. Previous testing of the sideward and rearward flight characteristics at low altitude is described in paragraphs 34 and 35 of reference 2, appendix A. Sideward, rearward, and slow-speed forward flight characteristics were investigated at high altitude by stabilizing the aircraft at incremental airspeeds up to the limits defined by the safety-of-flight release or at the airspeed requiring full deflection of the critical control. High-altitude tests were conducted at a constant radar altimeter height of 25 feet at the conditions listed in table 1. Airspeed was maintained by reference to a pace vehicle equipped with calibrated speedometer.

14. High-altitude IGE rearward and slow-speed forward flight test results are presented in figure 11, appendix C. Pitch attitude and control positions were essentially similar to those documented during low-altitude testing. Rearward and slow-speed forward flight were easily accomplished. The rearward and slow-speed forward flight characteristics were satisfactory.

15. High-altitude IGE sideward flight test results are presented in figure 12, appendix C. Lateral control position changes from hover to the maximum sideward velocity achieved were neutral to slightly stable (lateral control displacement in the direction of flight). Above 25 KTAS to the left and 5 KTAS to the right, the lateral control position gradient was essentially neutral. The maximum longitudinal control displacement of 1.[illegible] inches from the hover trim position occurred at a 30-KTAS left sideward flight. The directional control position changes with lateral flight speed were stable, except near 5 KTAS in left sideward flight, where a slight gradient reversal occurred. The reversal did not degrade the pilot's ability to stabilize at that airspeed. Left sideward flight was easily accomplished to the envelope limit (35 KTAS). Right sideward flight was readily accomplished to approximately 15 KTAS. At 15 KTAS, the maximum stabilized right sideward flight airspeed achieved, pilot workload was markedly increased. As shown in figure 12, at 15 KTAS in right sideward flight the left directional control pedal was only 0.8 inch (12 percent of control travel) from the limit of travel. At this 15-knot right sideward speed, directional control motions within 6 percent of the left directional control stop produced no noticeable aircraft response, and therefore only 0.4 inch (6 percent) of effective control travel was available. The maximum attainable steady-state right sideward speed of 15 KTAS failed to meet the 35-knot minimum requirement of paragraph 3.3.2, of MIL-H-8501A. The requirements of paragraph 3.3.6 of MIL-H-8501A were not met in that hovering turns over a spot on the ground could not be accomplished in winds over a 15-knot velocity. Stabilized right sideward flight was difficult at 15 KTAS and could not be achieved at higher speeds. Above 15 KTAS with full left directional control applied, the nose of the aircraft rotated uncontrollably to the right (HQRS 10). The loss of directional control within the allowable flight envelope, due to reaching the left directional control travel limit, in right sideward flight above 15 KTAS is a deficiency which must be corrected.

CONCLUSIONS

GENERAL

16. The following conclusions were reached upon completion of testing:

a. The S-67 helicopter cannot hover OGE at 95°F at the estimated 10% mission gross weight (para 9).

b. Retraction of the landing gear at 124 KTAS (maximum gear-down speed) resulted in an increase in airspeed of 13 KTAS (para 12).

c. One handling quality deficiency was observed during these high-altitude tests. Except for this deficiency, the handling qualities at high altitude were essentially the same as observed at low altitude. No shortcomings were noted which had not been reported during previous testing at low altitude.

DEFICIENCY AFFECTING MISSION ACCOMPLISHMENT

17. Correction of the following deficiency is mandatory: loss of directional control within the allowable flight envelope due to reaching the left directional control travel limit in right sideward flight above 15 KTAS (HQRS 10) (para 15).

SPECIFICATION COMPLIANCE

18. Within the scope of this test, the S-67 helicopter failed to meet the following requirements of the military specification, MIL-H-8501A:

a. Paragraph 3.3.2 -- The 15-KTAS maximum attainable airspeed in sideward flight failed to meet the 35-knot minimum requirement (para 15).

b. Paragraph 3.3.6 -- Hovering turns over a spot could not be accomplished in winds over a 15-KTAS velocity (para 15).

RECOMMENDATION

20. Loss of directional control in right sideward flight above 15 knots must be corrected (para 17).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-EFT, 9 March 1972, subject: Attack Helicopter Evaluation of the S-67 Helicopter, Project No. 72-09.

2. Final Report, USAASTA, Project No. 72-09, [illegible], July 1972.

3. Letter, AVSCOM, AMSAV-EFT, 5 July 1972, subject: S-67 High Altitude Tests, Project No. 72-26.

4. Military Specification, MIL-H-8501A, [illegible], 7 September 1961, with Amendment 1, 3 April 1962.

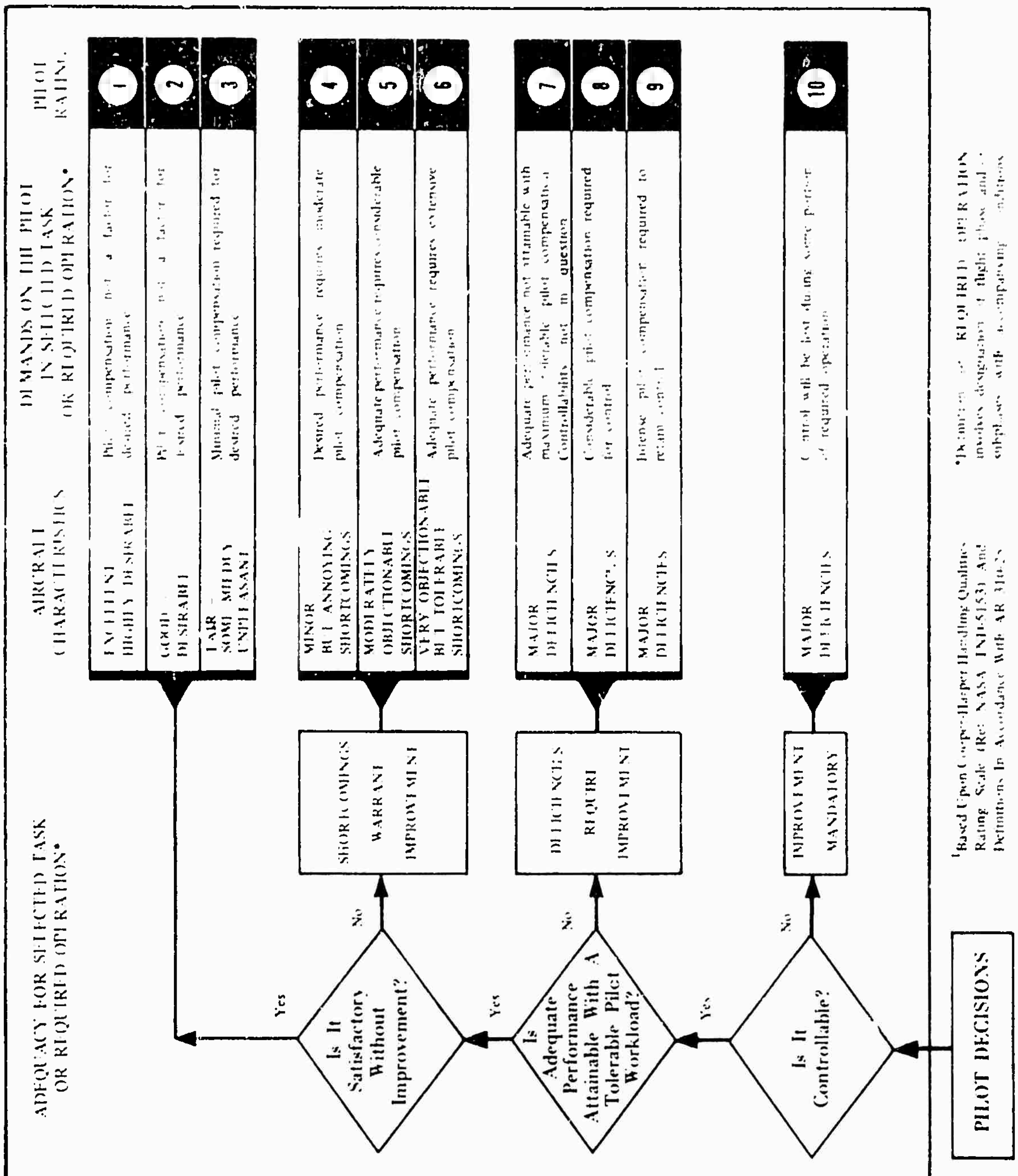
5. Checklist, "S-67 Blackhawk Pilot's Checklist," 1 May 1972.

6. Letter, AVSCOM, AMSAV-EF, 7 July 1972, subject: Safety of Flight Release for the Sikorsky S-67 BlackHawk High Elevation Flight Evaluation.

7. Flight Test Manual, Naval Air Test Center, FTM No. 101, [illegible], 10 June 1968.

8. Flight Test Manual, Naval Air Test Center, FTM No. 102, [illegible], 28 June 1968.

APPENDIX B. HANDLING QUALITIES RATING



APPENDIX C. TEST DATA

FIGURE 1
SUMMARY HOVER CAPABILITY COMPARISON
S-67 S/N N671SA
T58-GE-5 ENGINES
TAKEOFF POWER

NOTES:
1. POWER AVAILABLE BASED ON GENERAL ELECTRIC SOURCE DECK NO. P58115-A
2. HOVER DATA DERIVED FROM FIGURES 2 AND 3
3. ROTOR SPEED = 211 RPM
4. WIND LESS THAN 4 KNOTS
5. VERTICAL DISTANCE FROM BOTTOM OF WHEEL TO MAIN ROTOR CENTROID = 14.62 FT

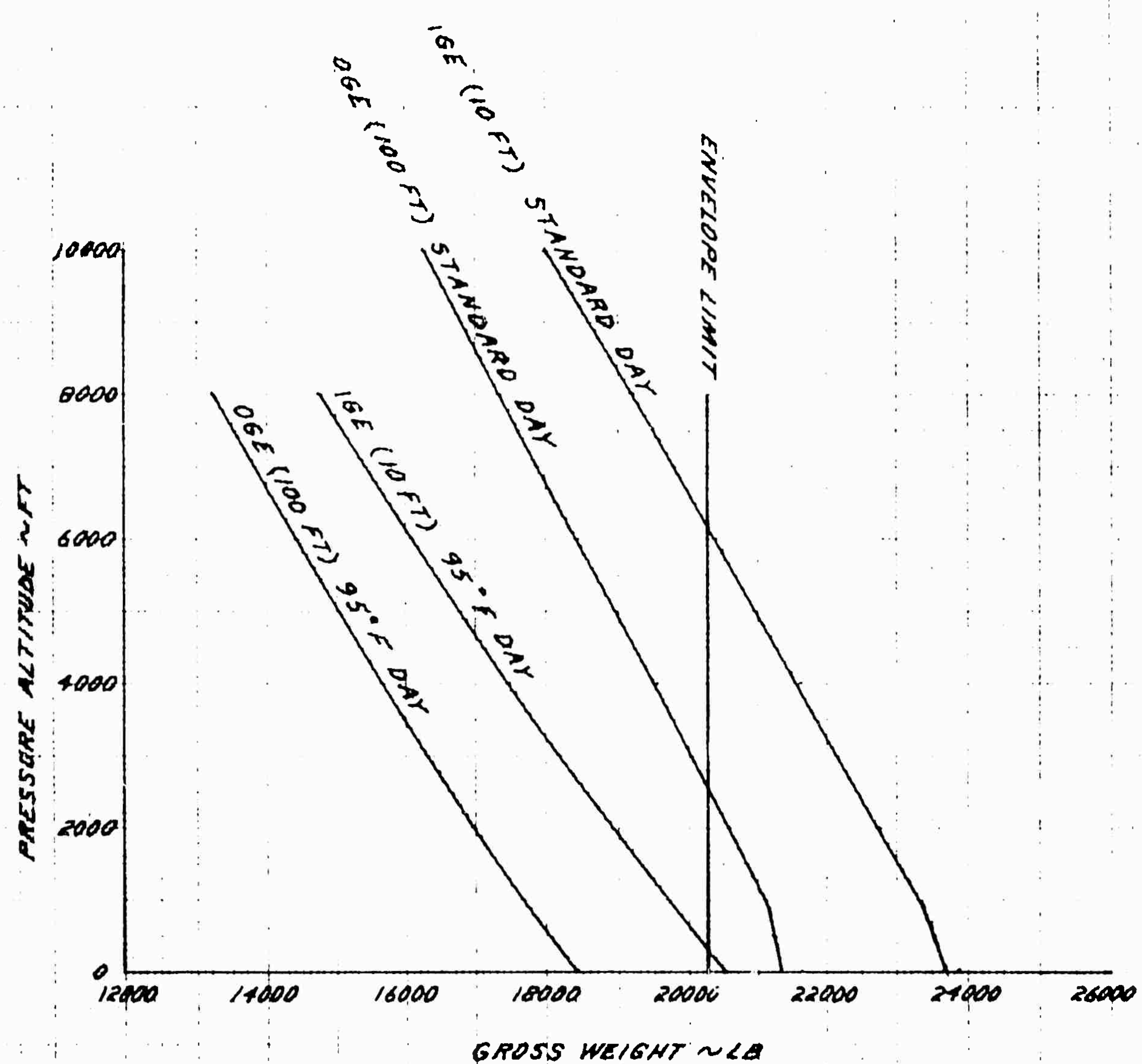
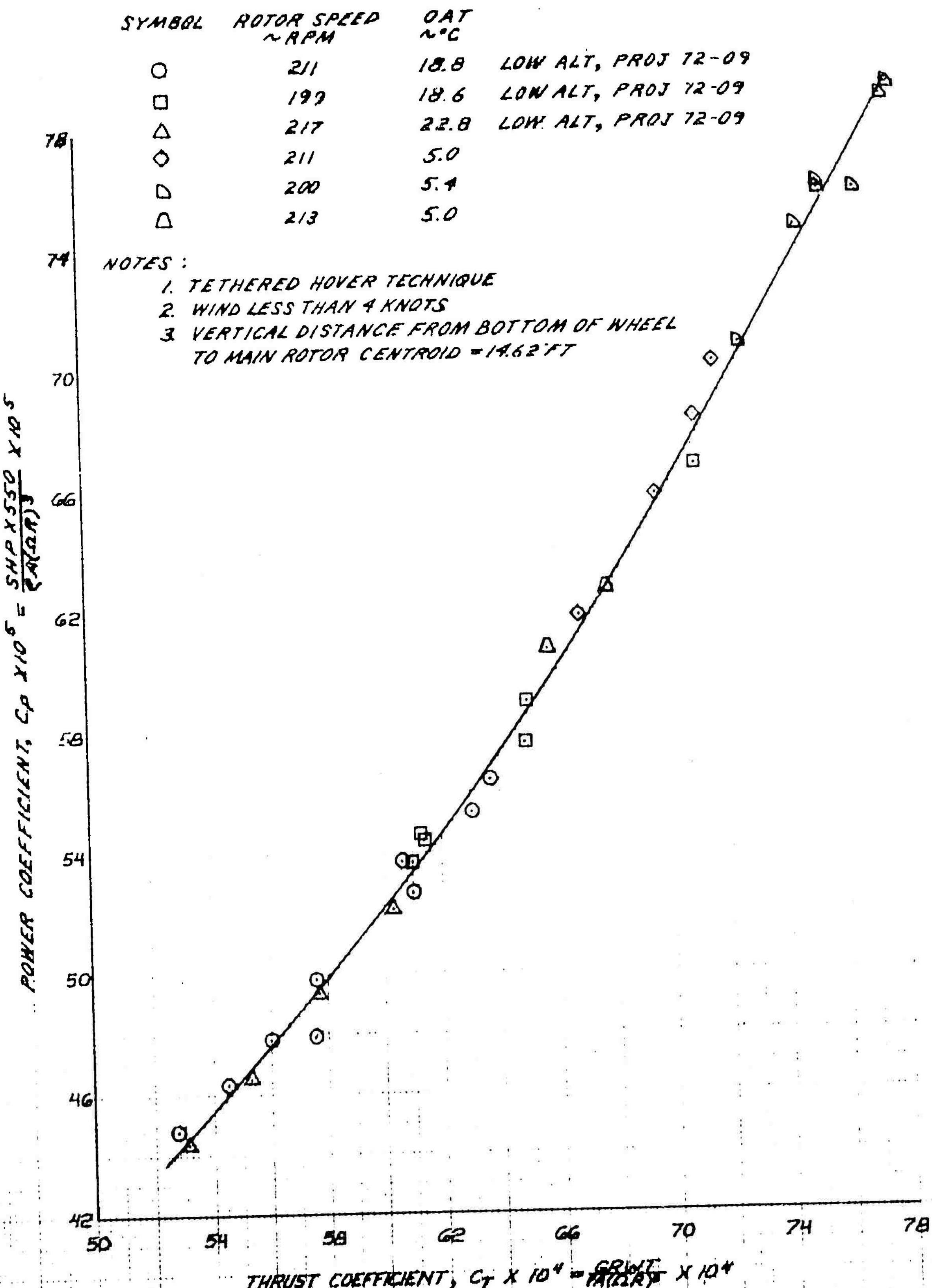


FIGURE 2
NON-DIMENSIONAL HOVERING PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES
WHEEL HEIGHT = 10 FT



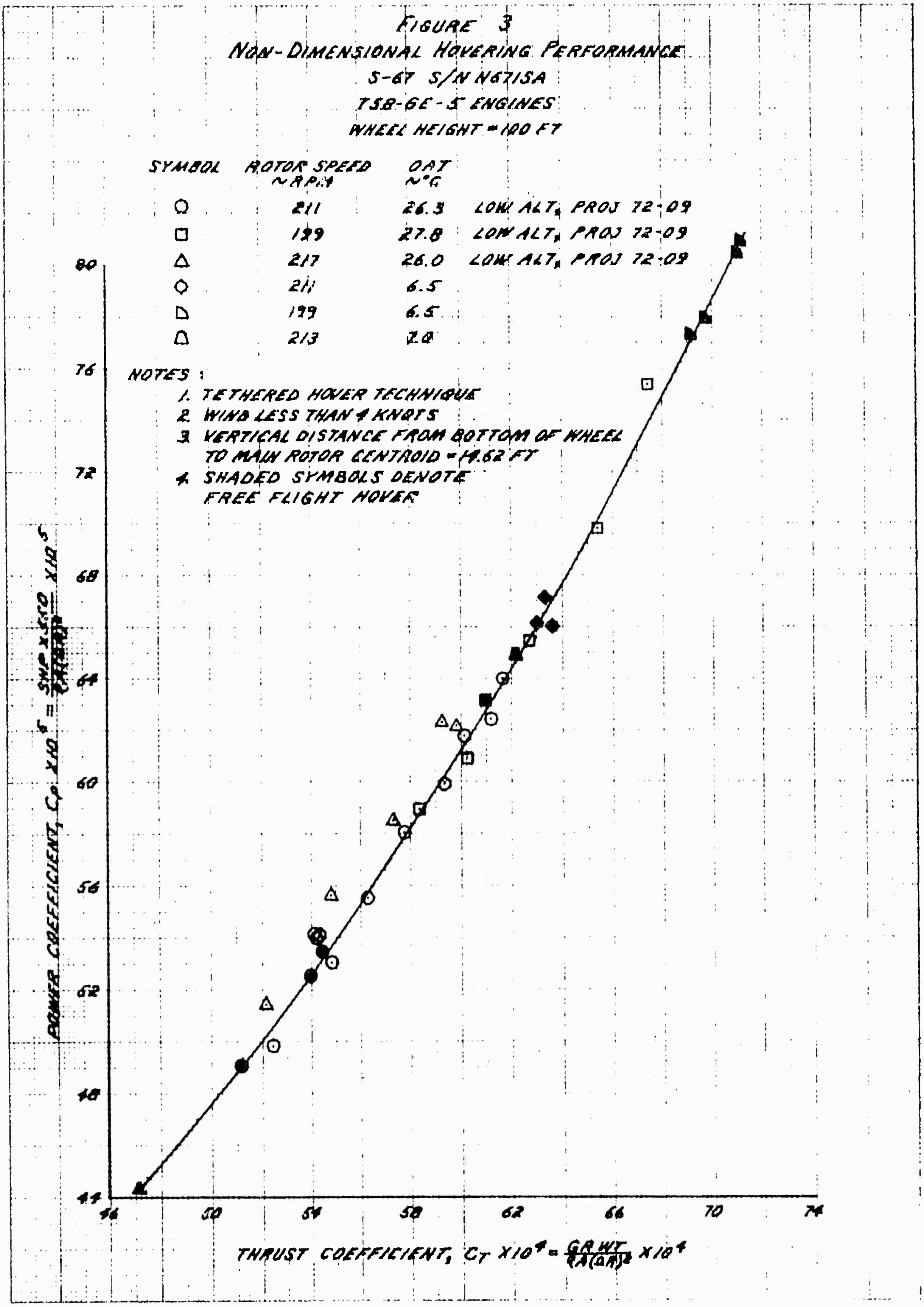


FIGURE 3
NON-DIMENSIONAL HOVERING PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES
WHEEL HEIGHT = 100 FT
SYMBOL
ROTOR SPEED ~RPM
OAT ~°C
211
26.3
LOW ALT, PROJ 72-09
199
27.8
LOW ALT, PROJ 72-09
217
26.0
LOW ALT, PROJ 72-09
211
6.5
199
6.5
213
2.0
NOTES:
1. TETHERED HOVER TECHNIQUE
2. WIND LESS THAN 4 KNOTS
3. VERTICAL DISTANCE FROM BOTTOM OF WHEEL TO MAIN ROTOR CENTROID = 14.62 FT
4. SHADED SYMBOLS DENOTE FREE FLIGHT HOVER
POWER COEFFICIENT, C_P X10⁵
THRUST COEFFICIENT, C_T X10⁴
80
76
72
68
64
60
56
52
48
44
46
50
54
58
62
66
70
74

FIGURE 4
NON-DIMENSIONAL TAIL ROTOR PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES
WHEEL HEIGHT = 10 FT

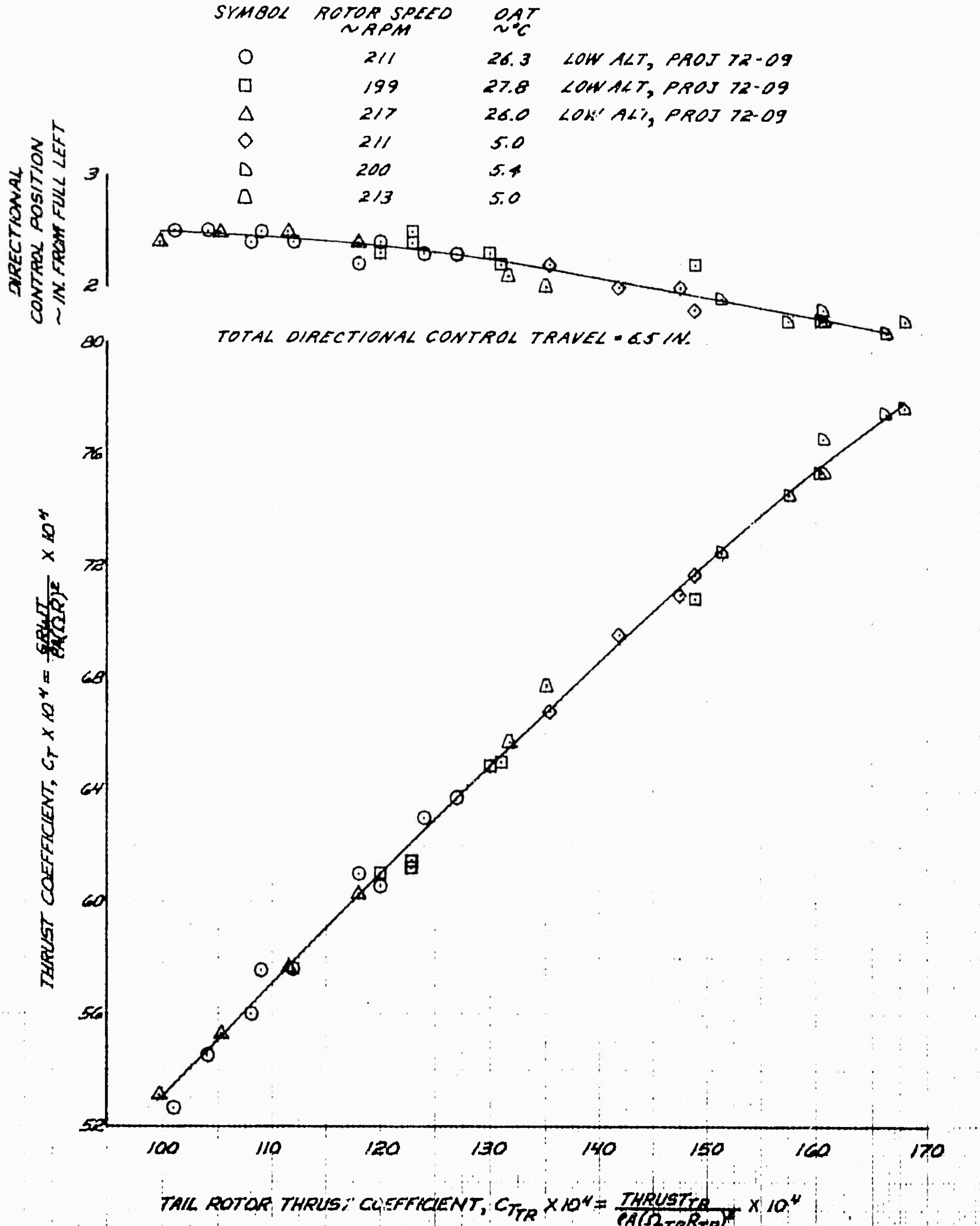


FIGURE 5
NON-DIMENSIONAL TAIL ROTOR PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES
WHEEL HEIGHT = 100 FT

SYMBOL	ROTOR SPEED ~RPM	OAT ~°C	
○	211	18.8	LOW ALT, PROJ 72-09
□	199	18.6	LOW ALT, PROJ 72-09
△	217	22.8	LOW ALT, PROJ 72-09
◇	211	6.5	
D	199	6.5	
Δ	213	7.0	

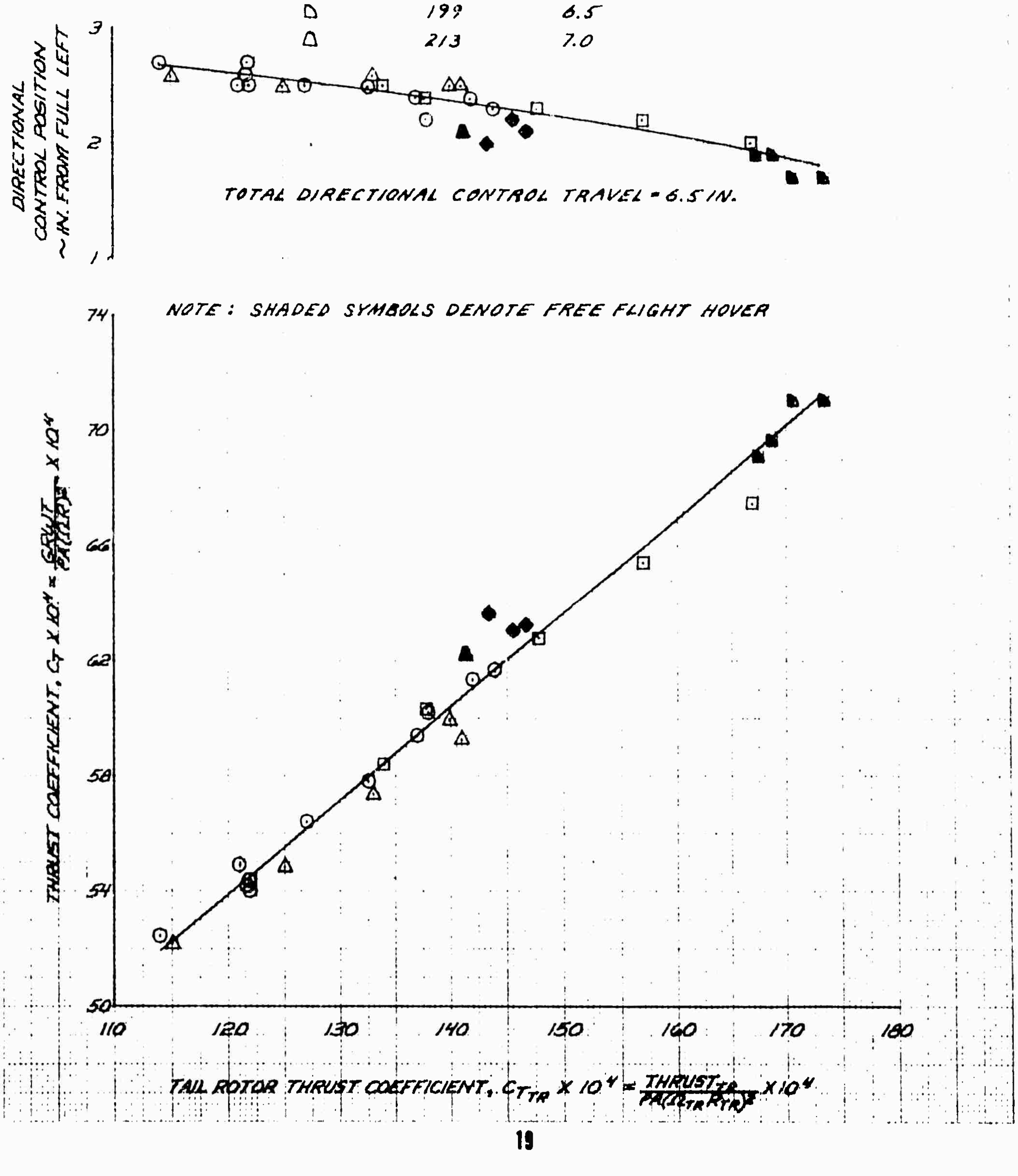


FIGURE 6
NON-DIMENSIONAL TAIL ROTOR POWER PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES
WHEEL HEIGHT = 10 FT

SYMBOL	ROTOR SPEED ~ RPM	OAT ~ °C	DENSITY ALTITUDE ~ FT	
○	211	26.3	1550	(PROJ 72-09)
□	199	27.8	1750	(PROJ 72-09)
△	217	26.0	1480	(PROJ 72-09)
◇	211	5.8	7880	
□	200	5.4	7850	
△	213	5.0	7800	

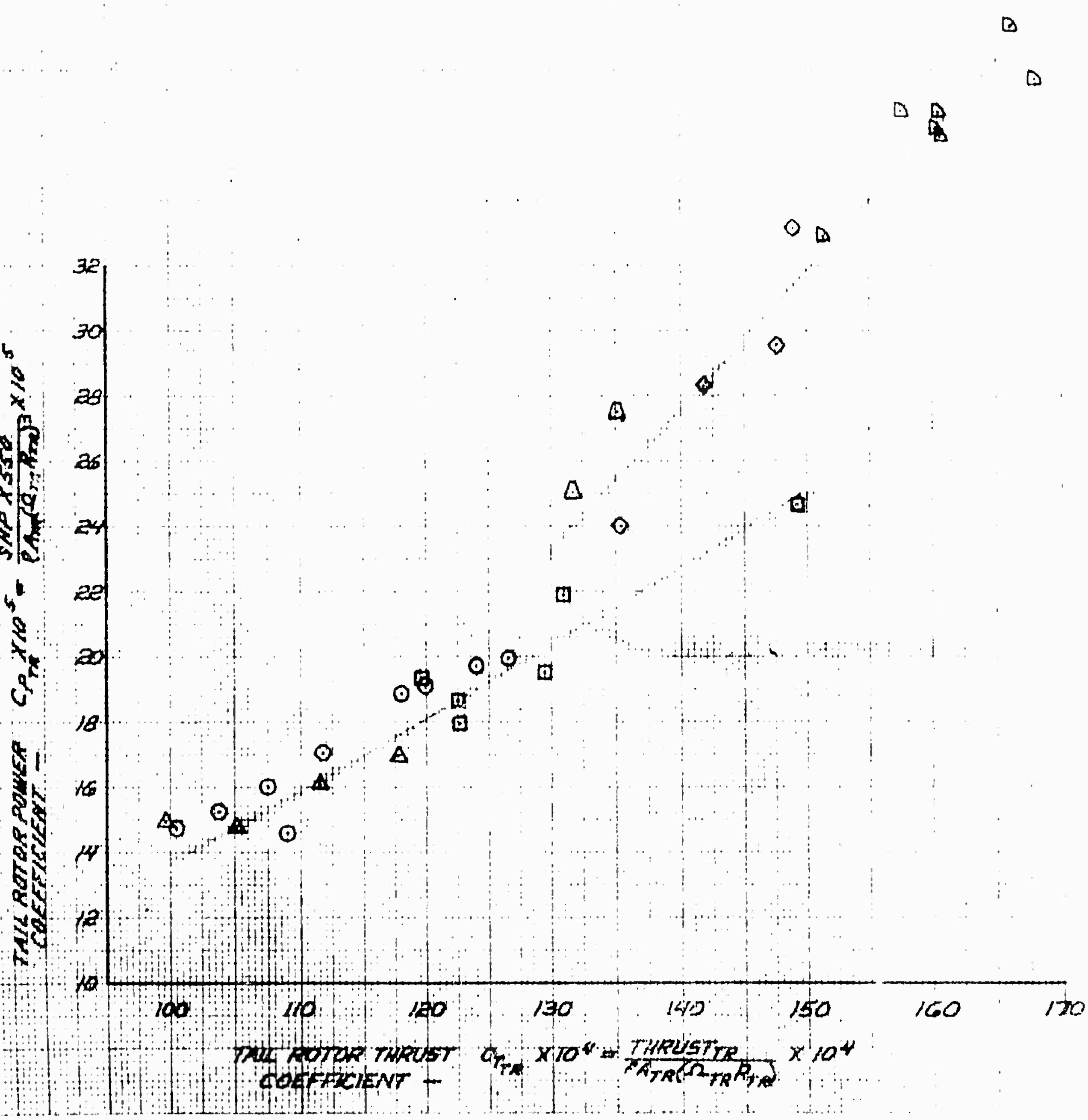


FIGURE 7

NON-DIMENSIONAL TAIL ROTOR POWER PERFORMANCE

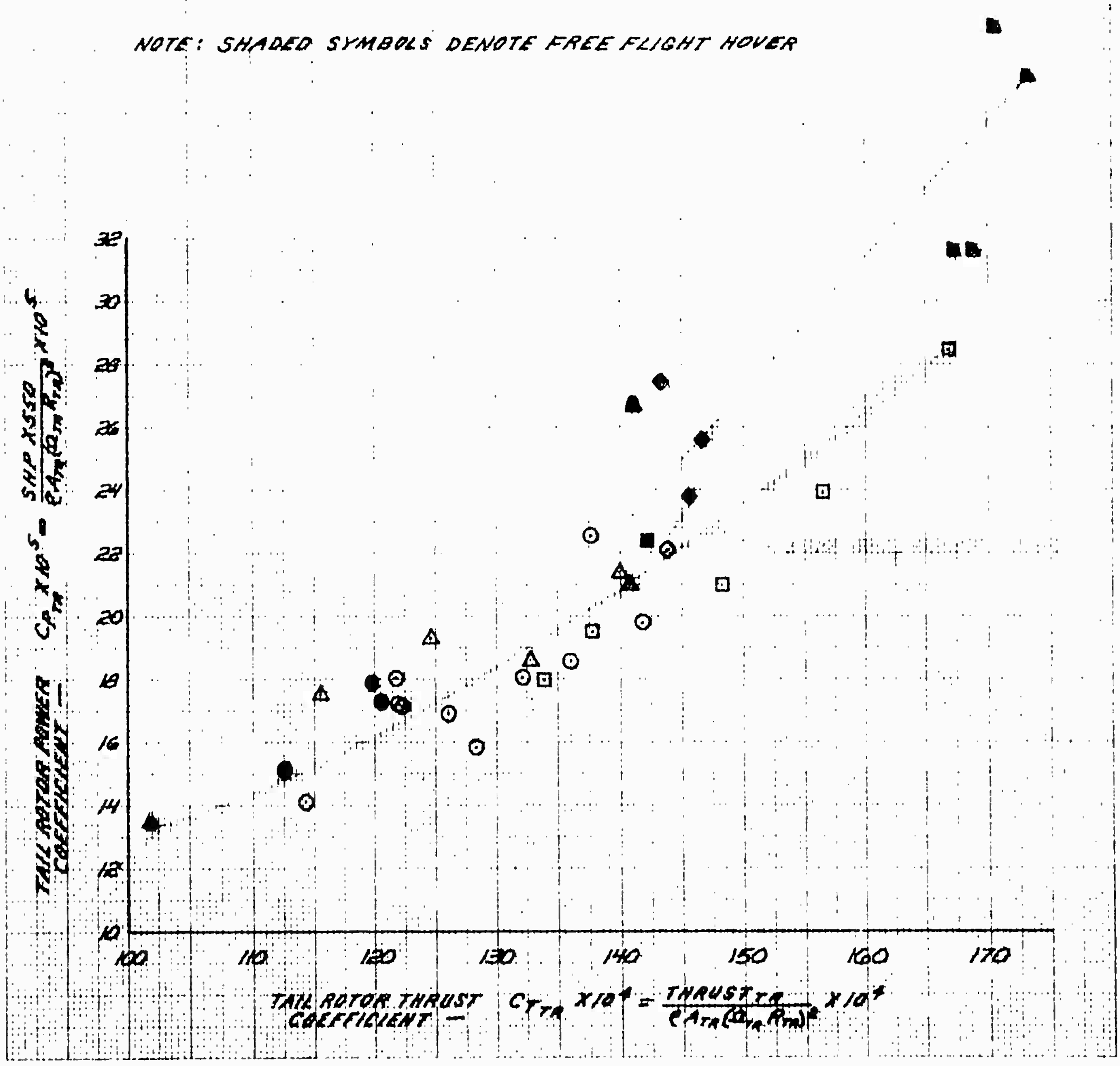
S-67 S/N N671SA

T58-GE-5 ENGINES

WHEEL HEIGHT ≈ 100 FT

SYMBOL	ROTOR SPEED ~ RPM	OAT ~°C	DENSITY ALTITUDE ~ FT	
○	211	18.8	1040	(PROJ 72-09)
□	199	18.6	1150	(PROJ 72-09)
△	217	22.8	1400	(PROJ 72-09)
◇	211	6.5	8100	
◺	199	6.5	8100	
△	213	7.0	8160	

NOTE: SHADED SYMBOLS DENOTE FREE FLIGHT HOVER



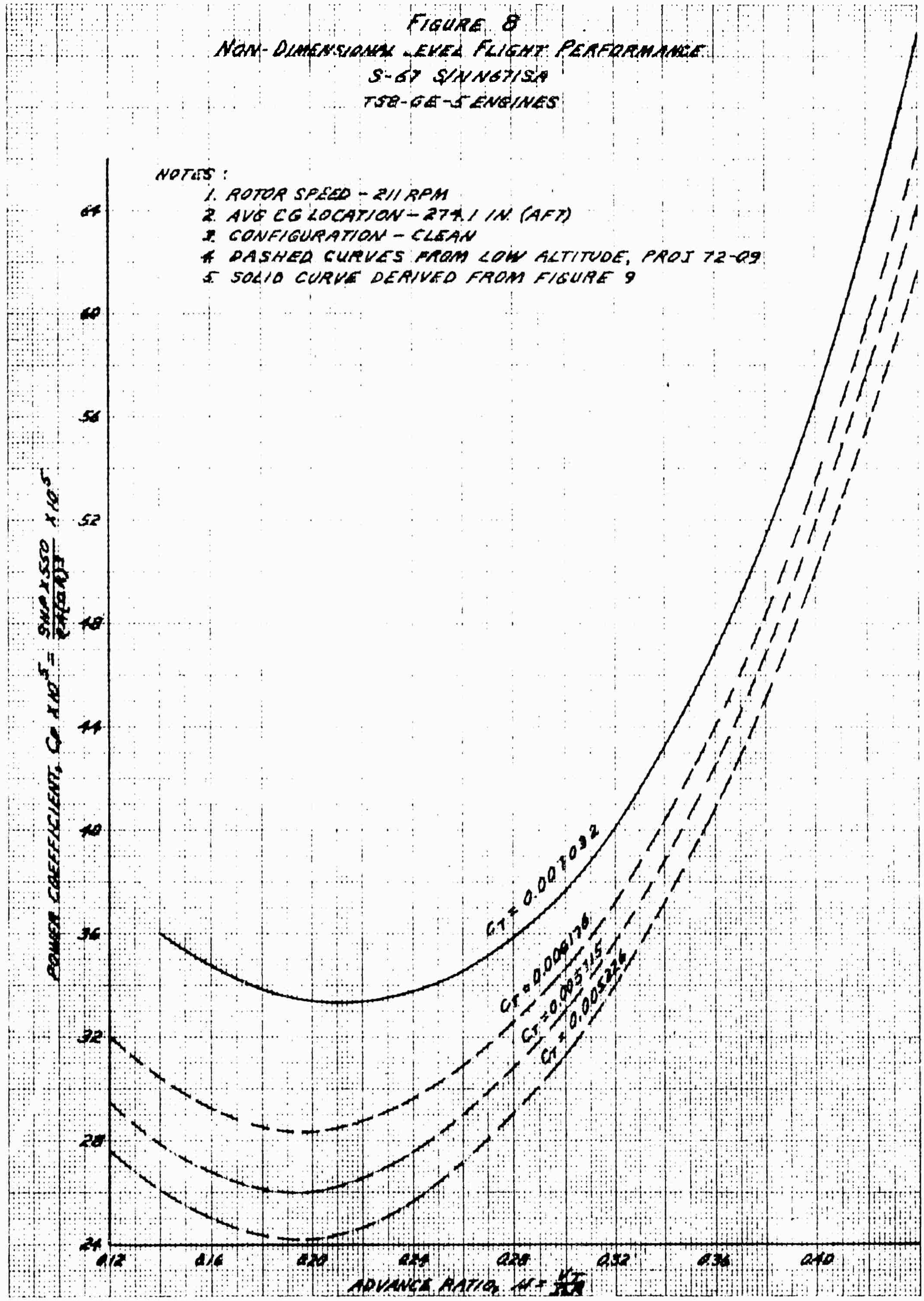


FIGURE 8
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES
NOTES:
1. ROTOR SPEED - 211 RPM
2. AVG CG LOCATION - 274.1 IN. (AFT)
3. CONFIGURATION - CLEAN
4. DASHED CURVES FROM LOW ALTITUDE, PROJ 72-09
5. SOLID CURVE DERIVED FROM FIGURE 9
$C_T = 0.007032$
$C_T = 0.006176$
$C_T = 0.005715$
$C_T = 0.005236$
64
60
56
52
48
44
40
36
32
28
24
0.12
0.16
0.20
0.24
0.28
0.32
0.36
0.40
ADVANCE RATIO, $\mu = \frac{V_T}{\Omega R}$

FIGURE 9
LEVEL FLIGHT PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES

AVG GROSS WEIGHT ~LB	AVG CG LOCATION ~IN.	AVG DENSITY ALTITUDE ~FT	AVG OAT ~°C	AVG ROTOR SPEED ~RPM	AVG C_T	CONFIGURATION
17020	274.5 (AFT)	10790	15.4	211	0.00703	CLEAN

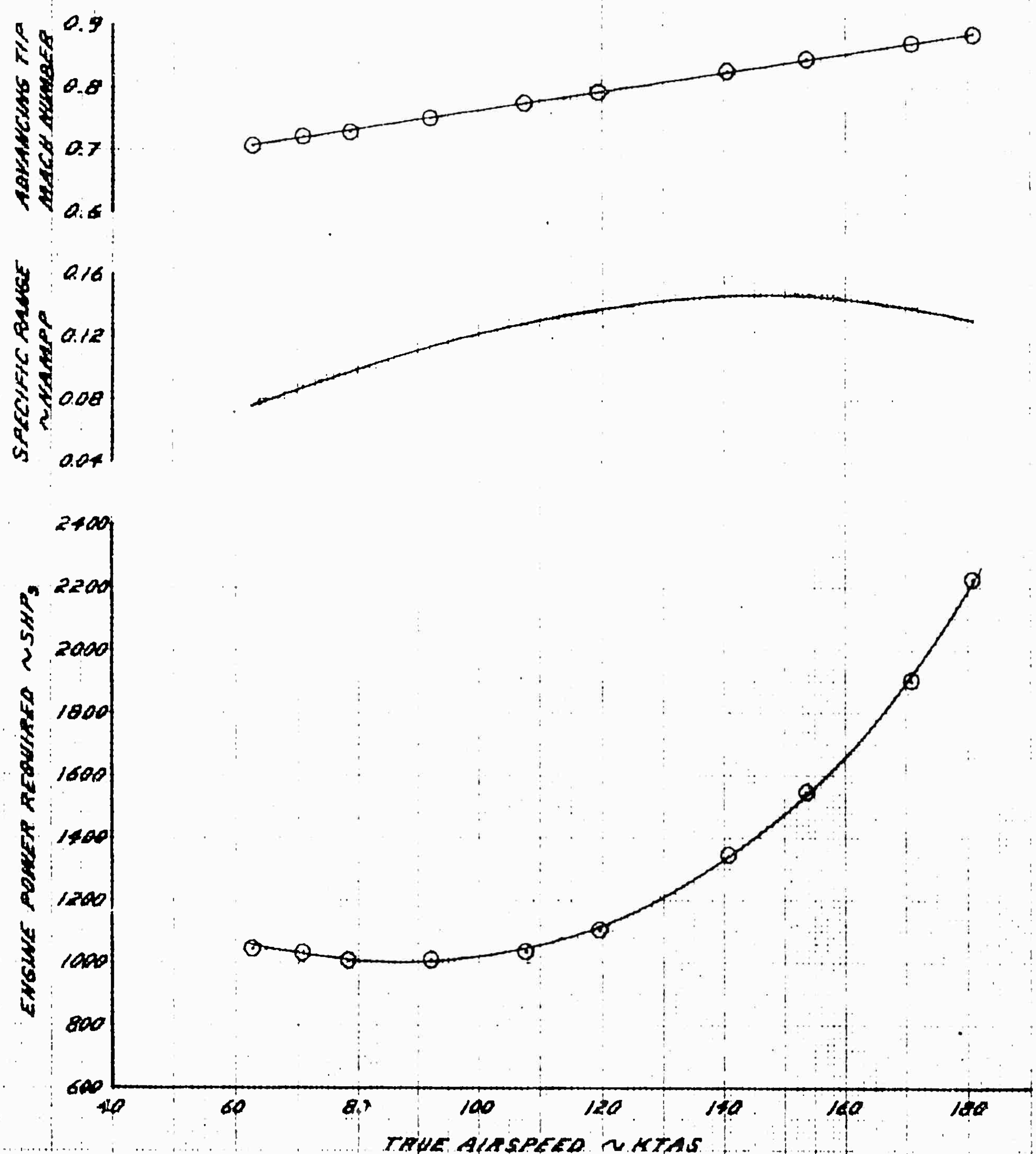


FIGURE 10
LEVEL FLIGHT PERFORMANCE
S-67 S/N N671SA
T58-GE-5 ENGINES

AVG GROSS WEIGHT ~LB	AVG CG LOCATION ~IN.	AVG DENSITY ALTITUDE ~FT	AVG OAT ~°C	AVG ROTOR SPEED ~RPM	AVG C_T	CONFIGURATION
17020	274.5 (AFT)	10790	15.4	211	0.007032	CLEAN-LANDING GEAR EXTENDED

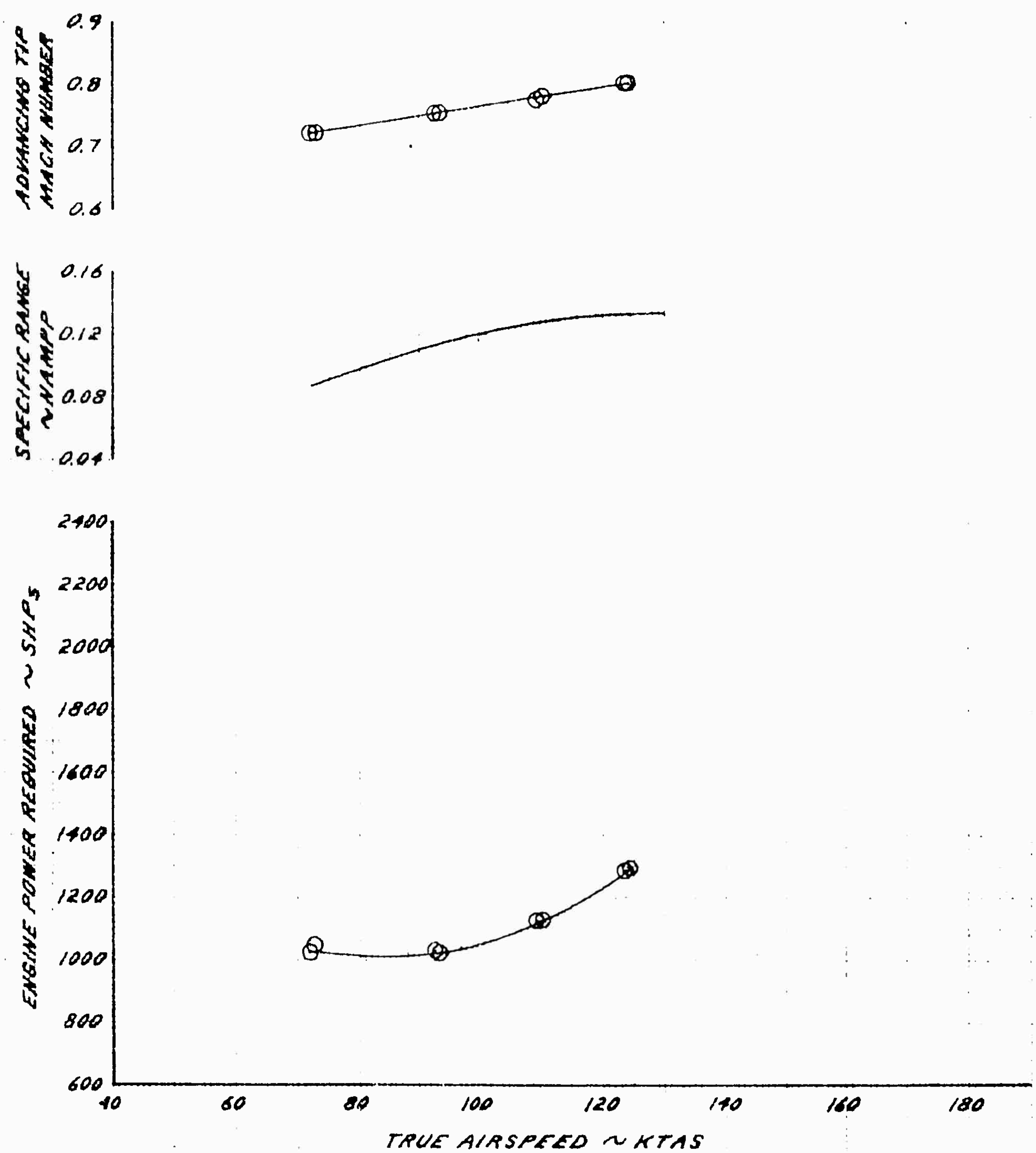
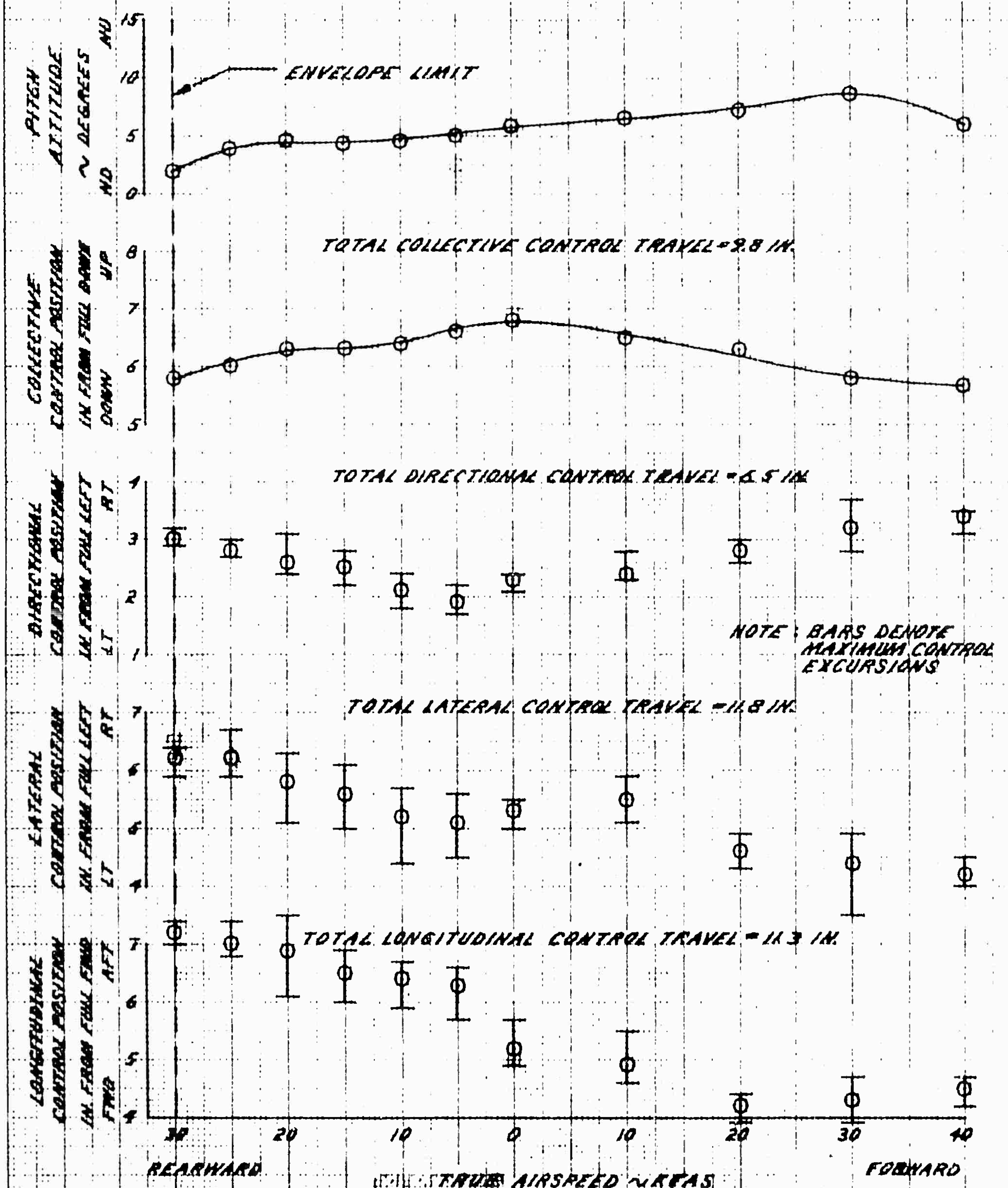


FIGURE 11
CONTROL POSITIONS IN REARWARD AND SLOW SPEED FORWARD FLIGHT
S-67 S/N N671SA

AVG GROSS WEIGHT ~LB	AVG CG LOCATION ~IN.	AVG DENSITY ALTITUDE ~FT	AVG OAT ~°C	AVG ROTOR SPEED ~RPM	AVG C_T	CONFIGURATION
16750	274.3	8050	6.8	211	0.00633	CLEAN



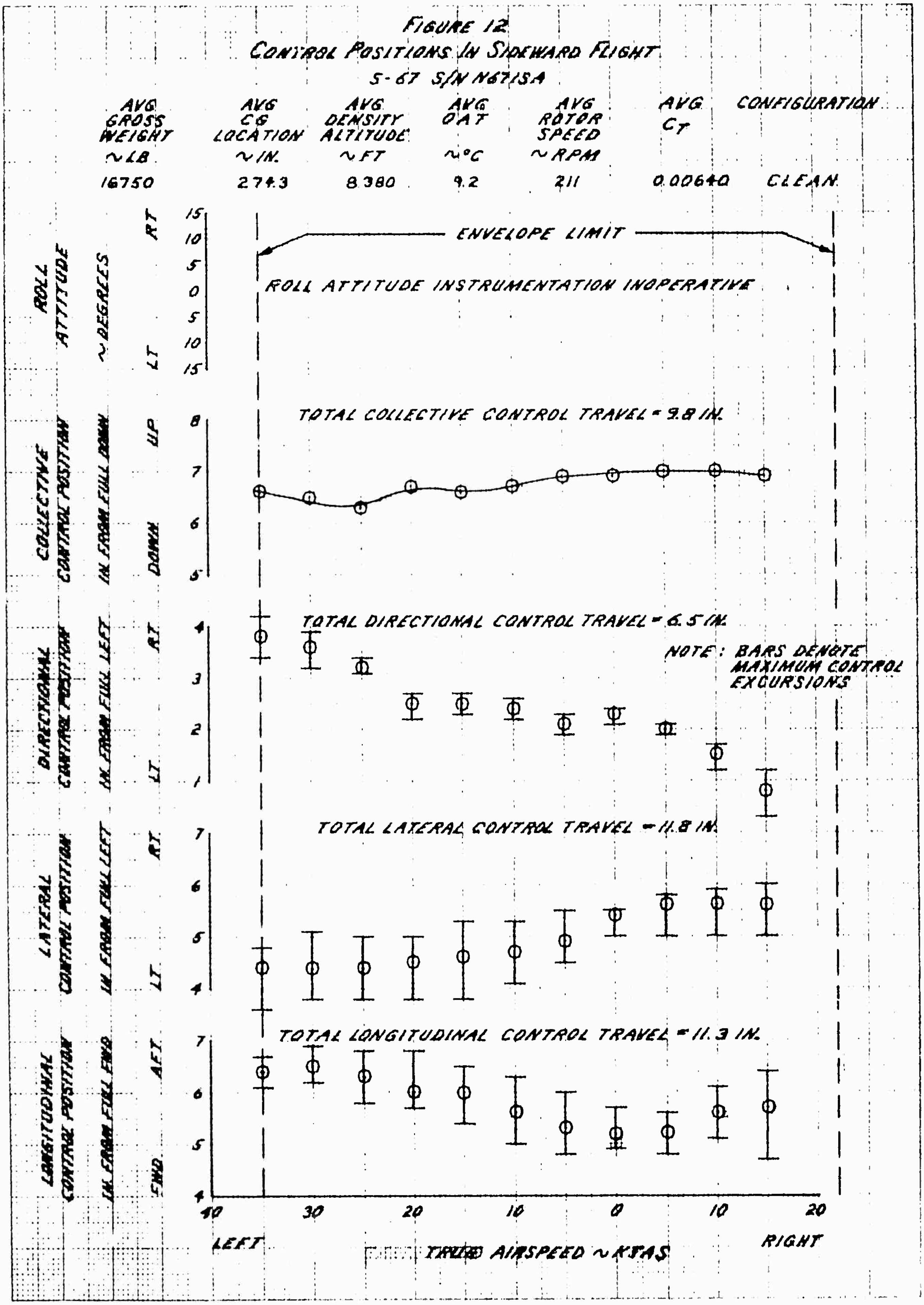


FIGURE 12
CONTROL POSITIONS IN SIDEWARD FLIGHT
S-67 S/N N671SA
AVG GROSS WEIGHT ~LB
AVG CG LOCATION ~IN.
AVG DENSITY ALTITUDE ~FT
AVG OAT ~°C
AVG ROTOR SPEED ~RPM
AVG C_T
CONFIGURATION
16750
274.3
8380
9.2
211
0.00640
CLEAN
ENVELOPE LIMIT
ROLL ATTITUDE INSTRUMENTATION INOPERATIVE
ROLL ATTITUDE ~DEGREES
RT
LT
TOTAL COLLECTIVE CONTROL TRAVEL = 9.8 IN.
COLLECTIVE CONTROL POSITION IN. FROM FULL DOWN
UP
DOWN
TOTAL DIRECTIONAL CONTROL TRAVEL = 6.5 IN.
NOTE: BARS DENOTE MAXIMUM CONTROL EXCURSIONS
DIRECTIONAL CONTROL POSITION IN. FROM FULL LEFT
TOTAL LATERAL CONTROL TRAVEL = 11.8 IN.
LATERAL CONTROL POSITION IN. FROM FULL LEFT
TOTAL LONGITUDINAL CONTROL TRAVEL = 11.3 IN.
LONGITUDINAL CONTROL POSITION IN. FROM FULL FWD
AFT
FWD
LEFT
RIGHT
TRUE AIRSPEED ~KTAS